TM 11-4063

TO 16-40BC-1159-5

WAR DEPARTMENT TECHNICAL MANUAL

BEARING INDICATOR BC-1159-A

REPAIR INSTRUCTIONS

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WAR DEPARTMENT • DECEMBER 1945

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WAR DEPARTMENT

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TM 11–4063, Bearing Indicator BC–1159–A, Repair Instructions, is published for the information and guidance of all concerned.

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Refer to FM 21–6 for explanation of distribution formula.

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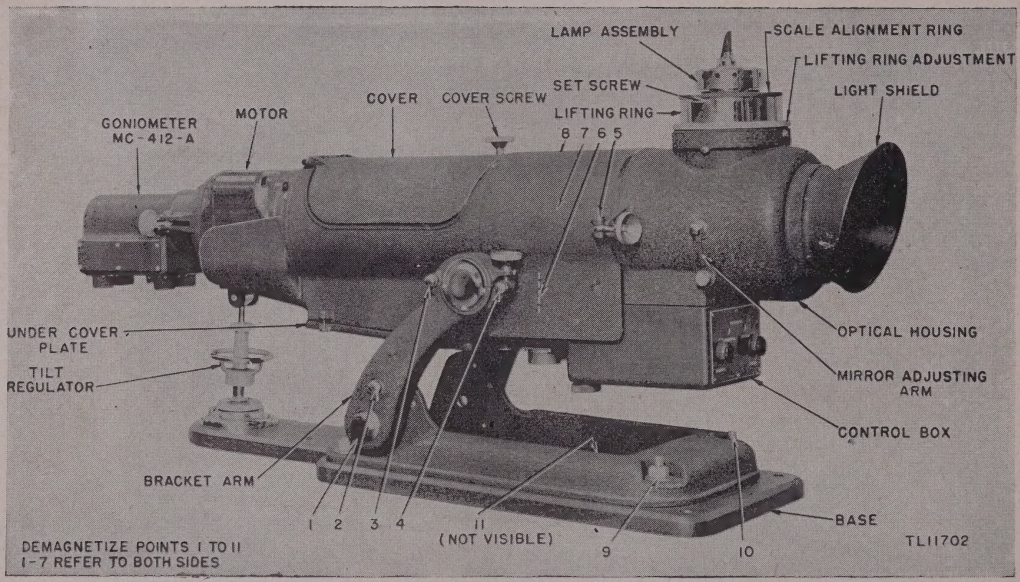


Figure 1. Bearing Indicator BC-1159-A.

SECTION I
DESCRIPTION OF BEARING INDICATOR BC–1159–A*

1. General

Indicator BC–1159–A is an electromechanical optical unit for producing visual bearing and sense patterns which are characteristic of the associated antenna system with its associated goniometer. These visual patterns of the response of the antenna system to an incoming signal give a direct indica-

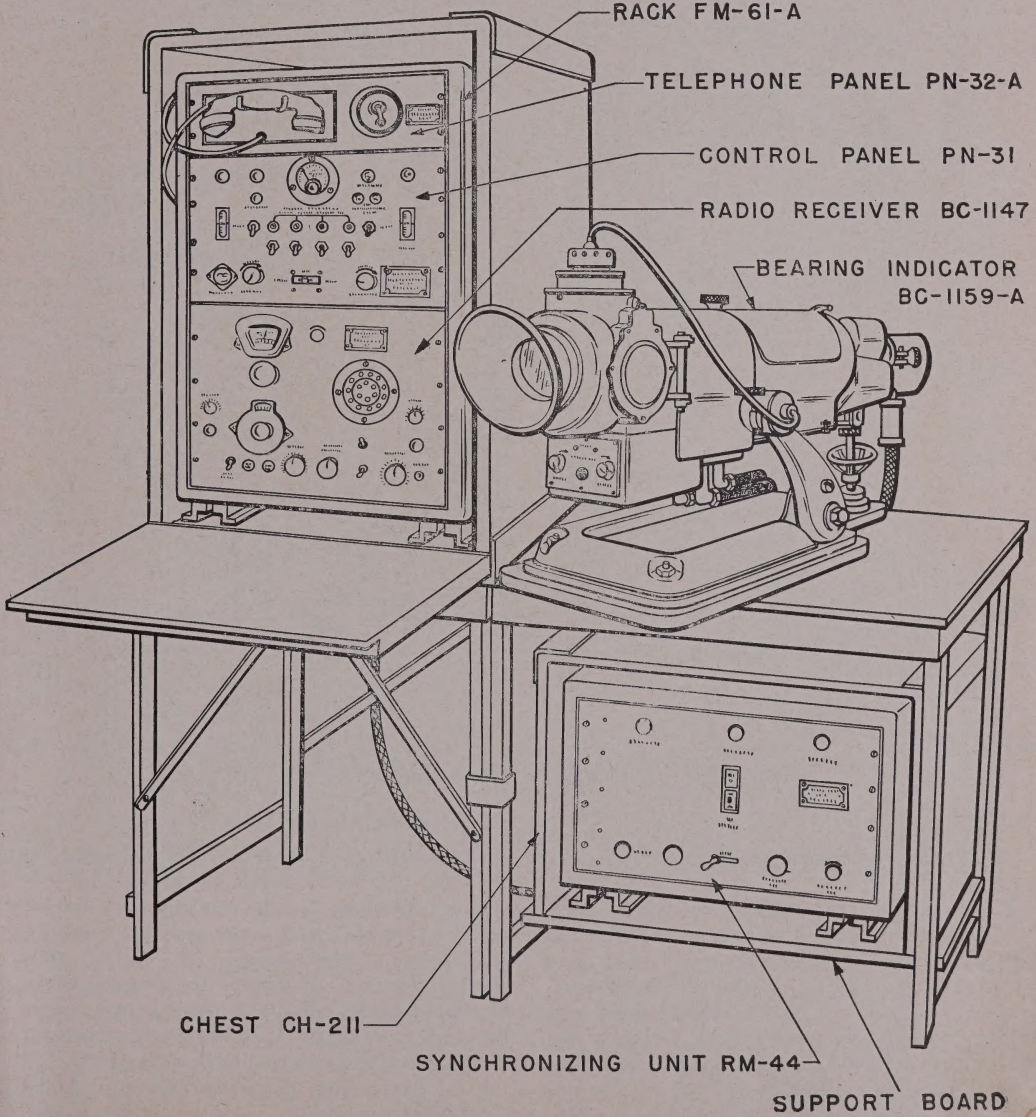


Figure 2. Radio Set SCR-502 (Direction Finding), operating equipment in Shelter HO-20-A. TL 11797–S

*See TM 11-256 for installation, operation, and other maintenance data on this equipment.

tion (azimuth bearing) of the direction from which the signals are received. The entire unit consists of a cathode-ray tube, its complementary electrical network rotating deflection coils, a single-phase synchronous motor, and an optical system. Goniometer MC–412–A or Contactor MC–473 is mounted at the rear of the indicator and is driven by the motor. (See figs. 1, 2, and 3.) The main mechanical elements of support, the housing, and the auxiliary pieces are made of aluminum castings finished in gray wrinkle enamel.

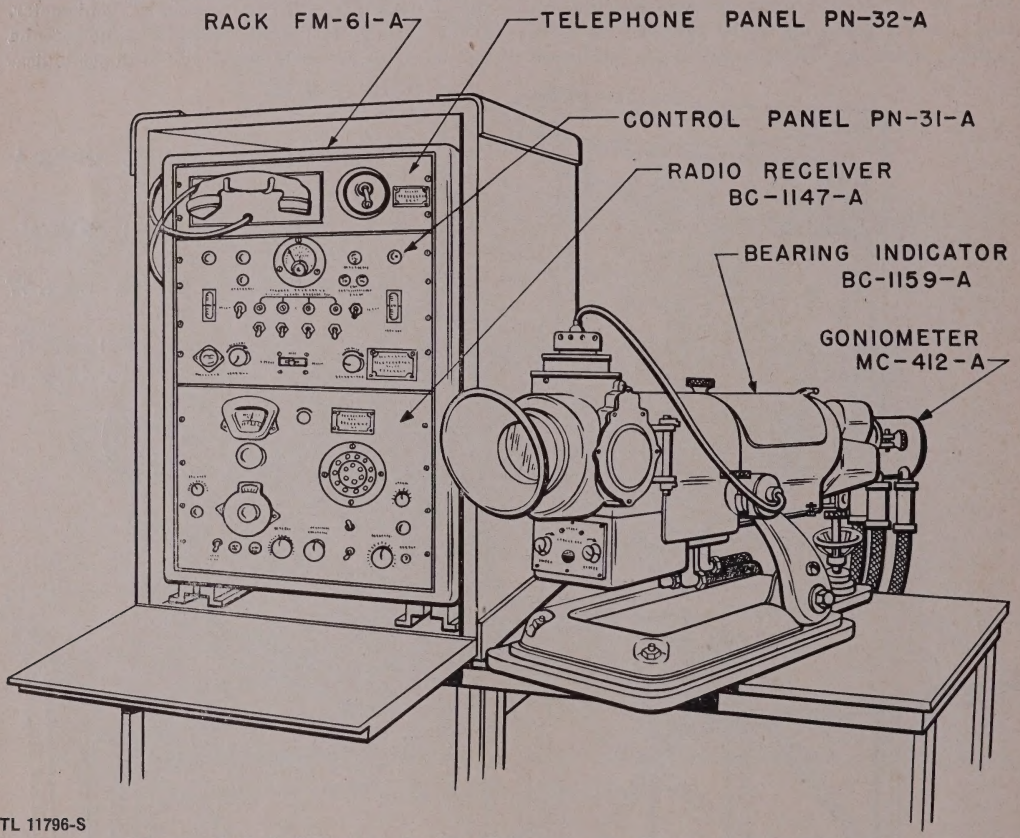


Figure 3. Radio Set SCR–291–A (Direction Finding), operating equipment in Shelter HO–20–A.

2. Components

a. Motor: ¼ horsepower (hp), 1,800 rpm synchronous.

b. Cathode-ray tube: 5NP1 or special 5BP1.

c. Deflection coils: Two sets, one for direction finding and one for sense patterns, located on a motor-driven housing around the cathode-ray tube.

d. Optical system: Lamp, azimuth scale, and mirror assembly for projecting an image of the azimuth scale around the cathode-ray tube screen.

e. Control box: Circuits and controls for centering and adjusting the intensity and focus of the cathode-ray tube patterns.

3. Mechanical Construction

a. Housing. The principal housing consists of a tubular type heavy aluminum casting supported on a cast aluminum base by two adjustable bracket arms and an adjustable screw type tilt regulator, at the rear of the housing. (See fig. 1.) The bracket arms are adjusted by the setscrew above the base support bolt. The motor is mounted at the rear, and hinged thumbscrews are provided for clamping the goniometer back of the motor.

b. Control Box. The control box is of the plug-in type and mounts under the optical housing. (See figs. 1 and 4.) Receptacles J–501 and J–502

for connection to Control Panel PN–31–A are at the rear of the control box, and J–503 is on the main housing. The optical housing may be swung aside for removing the cathode-ray tube from its support, shown disassembled in figure 4. The lamp assembly is mounted over the optical housing (fig. 1), and its cord is plugged into receptacle J–504 in the right-hand side bracket (fig. 3).

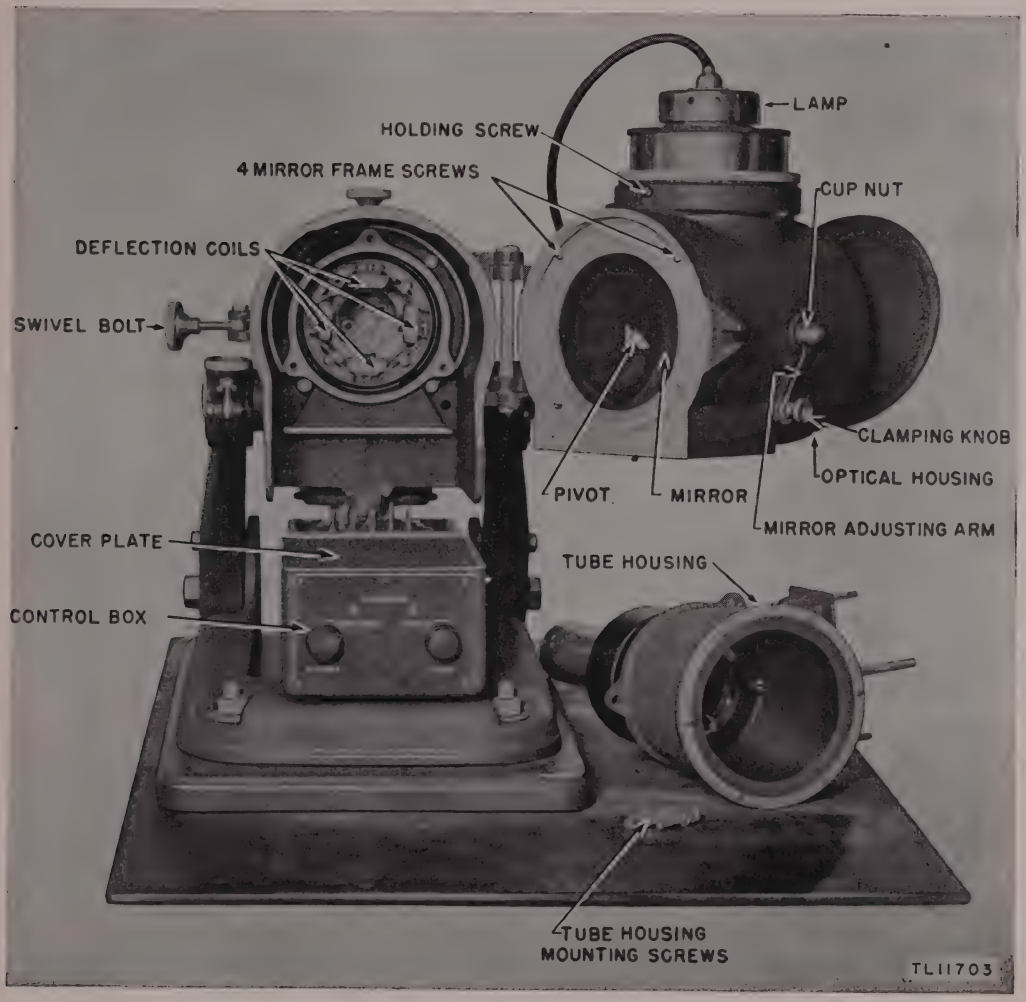


Figure 4. Bearing Indicator BC–1159–A, partially dismantled to show deflection coils.

c. Rotating Deflection Coil Assembly. The two sets of deflection coils are mounted on a four-pole laminated yoke. (See fig. 4.) The yoke is mounted in a tubular aluminum shell, which in turn is encased within a steel shell and shaft assembly. This assembly is rotated around a hollow bakelite housing attached to the tube-support housing. The tube-support housing is bolted to the flange in front of the rotating assembly as shown in figure 4. Figure 5 is a top view of the indicator with the cover swung back showing the flexible motor coupling, axle and worm coupling, front and rear bearing housing and oil holes, brushes and slip rings, and the graduated indexing ring. The deflection-coil yoke is under the flared portion of the assembly between the front bearing housing

and point A of figure 5. Point A is the threaded seat for the cover thumbscrew shown in figure 1. Electrical connections from the control box circuits to the rotating coils are made through the brushes and slip rings.

d. Motor Coupling and Alignment Devices. (1) *Goniometer coupling.* Pin and slot coupling arms on the goniometer rotor and rear motor shafts connect the goniometer to the indicator motor.

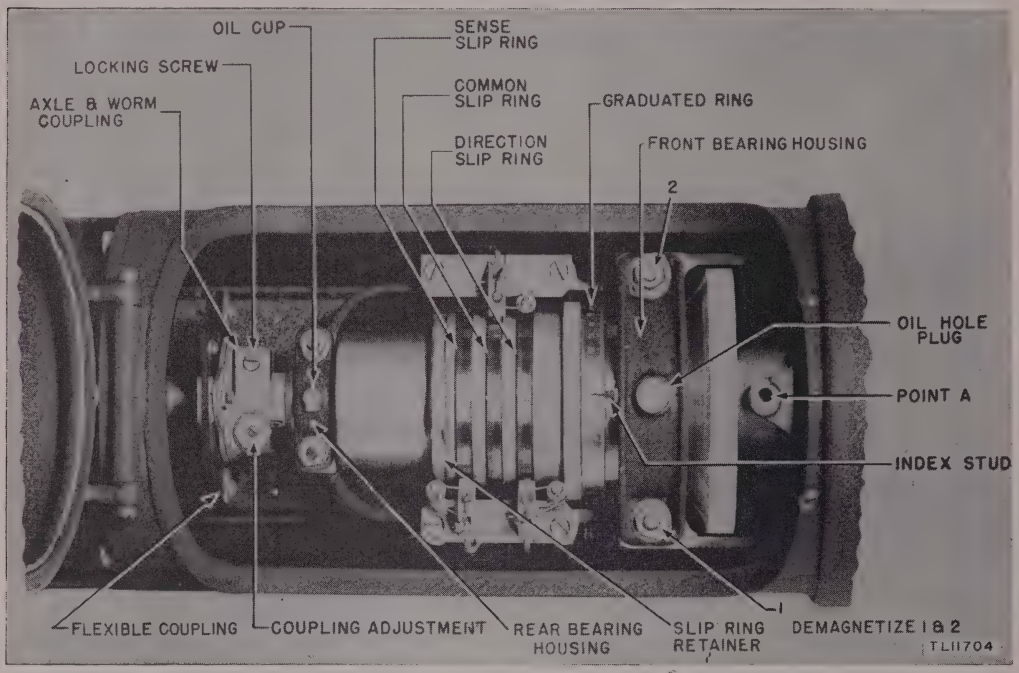


Figure 5. Bearing Indicator BC–1159–A, top view showing rotating assembly.

(2) *Rotating deflection coil coupling.* A flexible leather coupling connects the forward motor shaft extension to the coil assembly shaft. This assembly may be oriented with respect to the goniometer rotor and motor, up to 360°, by means of the screw driver coupling adjustment on the axle and worm coupling mechanism. (See fig. 5.) The graduated ring and index stud permit accurate adjustments of any necessary amount to orient the pattern for correct reading on the azimuth scale, whose 0° north point is at the top of the cathode-ray tube screen.

e. Optical System. The optical system consists of a lamp, reflector, azimuth scale, and mirror assembly for projecting an image of the azimuth scale on the cathode-ray tube screen.

4. Over-all System Function

a. Function in Radio Set SCR–291–A (Direction Finding) (fig. 7). The antenna system feeds directly into Goniometer MC–412–A, which is mounted on the rear of the bearing indicator. The received signals are then fed into Radio Receiver BC–1147–A where they are amplified and detected. The output of the receiver is further amplified by a direct current (d-c) amplifier, and then applied to the deflection coils of Bearing Indicator BC–1159–A. A visual pattern of the antenna-system characteristic is produced on the screen of the cathode-ray tube by the effect of the rotating coils on the electron beam. Synchronization is positive in the system because the deflection coils and the goniometer are driven by the same synchronous motor. An optical system projects an azimuth scale on a transparent mirror in such a manner that the azimuth scale appears to be in the same plane as the cathode-ray screen. Observing and interpreting the bearing pattern yields information as to the direction from which the radio signal is being received.

b. Function in Radio Set SCR–502 (Direction Finding) (fig. 8). The over-all opera-

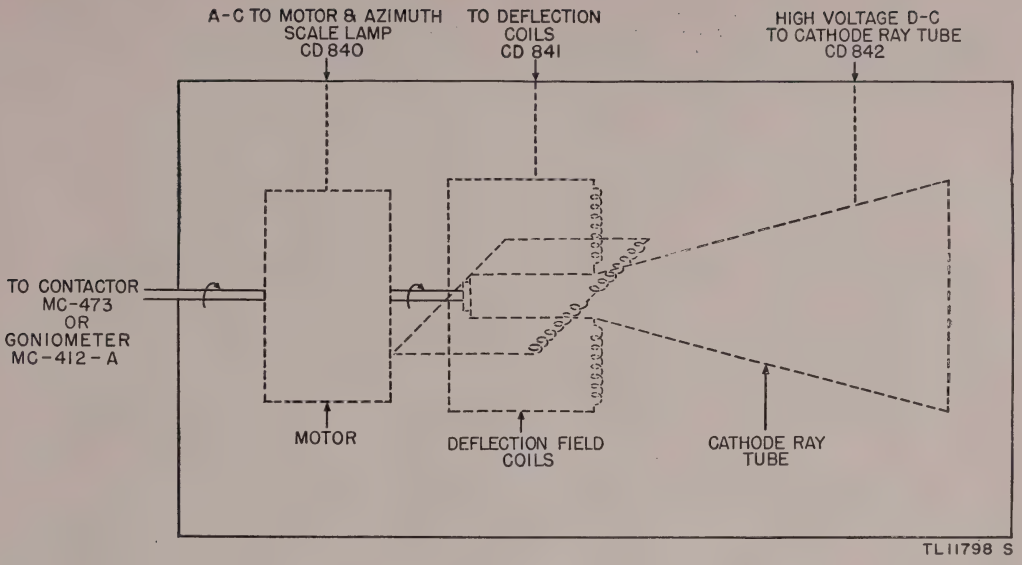

A-C TO MOTOR & AZIMUTH SCALE LAMP CD 840
TO DEFLECTION COILS CD 841
HIGH VOLTAGE D-C TO CATHODE RAY TUBE CD 842
TO CONTACTOR MC-473 OR GONIOMETER MC-412-A
MOTOR
DEFLECTION FIELD COILS
CATHODE RAY TUBE
TL11798 S

Figure 6. Bearing Indicator BC–1159–A, block diagram.

tion of Radio Set SCR–502 (Direction Finding) is identical with that of Radio Set SCR–291–A (Direction Finding) with the exception of the method used for driving and synchronizing the deflection coils and the goniometer. The goniometer and the deflection coils are each driven by a

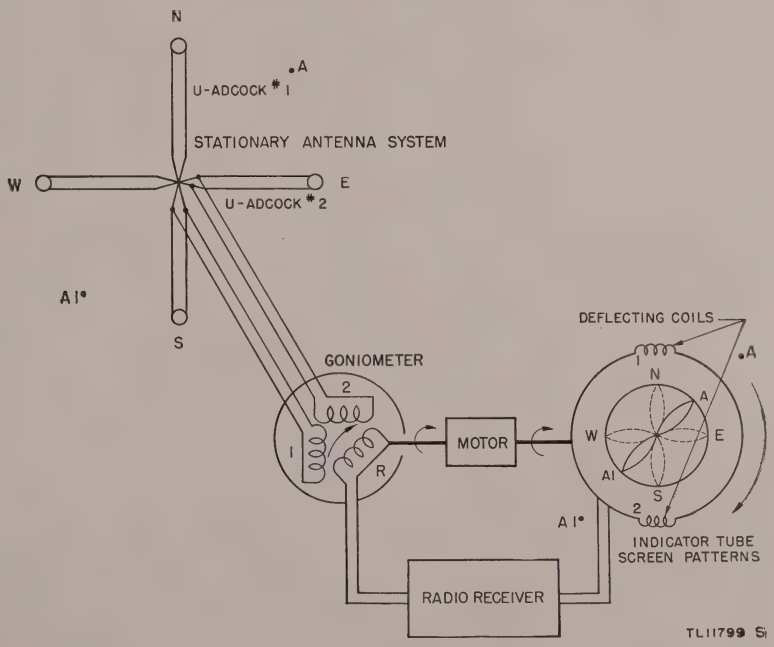


Figure 7. Radio Set SCR–291–A (Direction Finding), functional diagram.

separate motor and the two motors kept in synchronization by Synchronizing Unit RM–44. The function and operation of the bearing indicator in this radio set is identical to that in Radio Set SCR–291–A (Direction Finding).

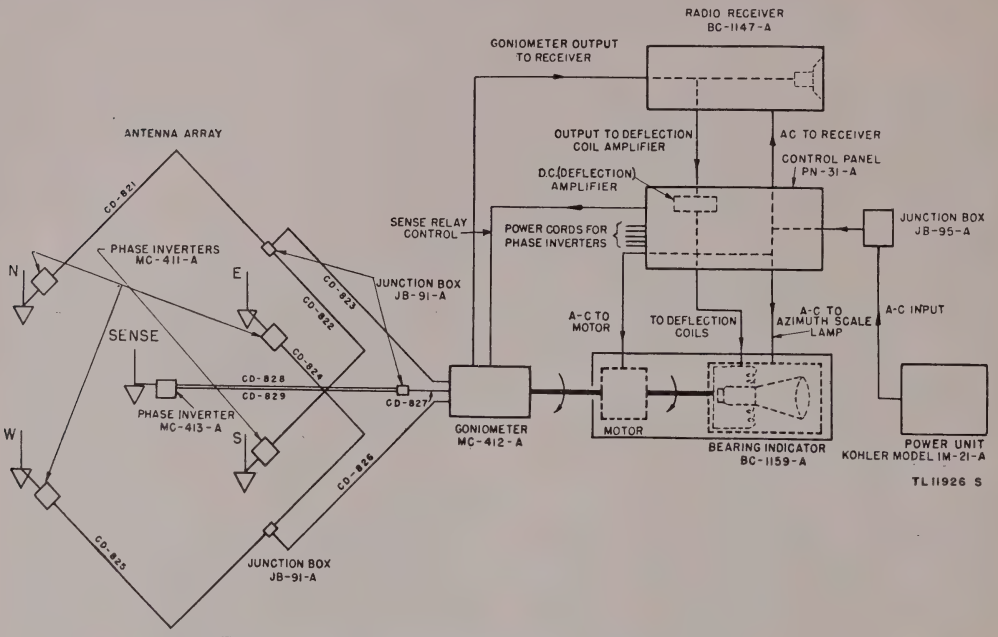


Figure 8. Radio Set SCR–291–A (Direction Finding), block diagram.

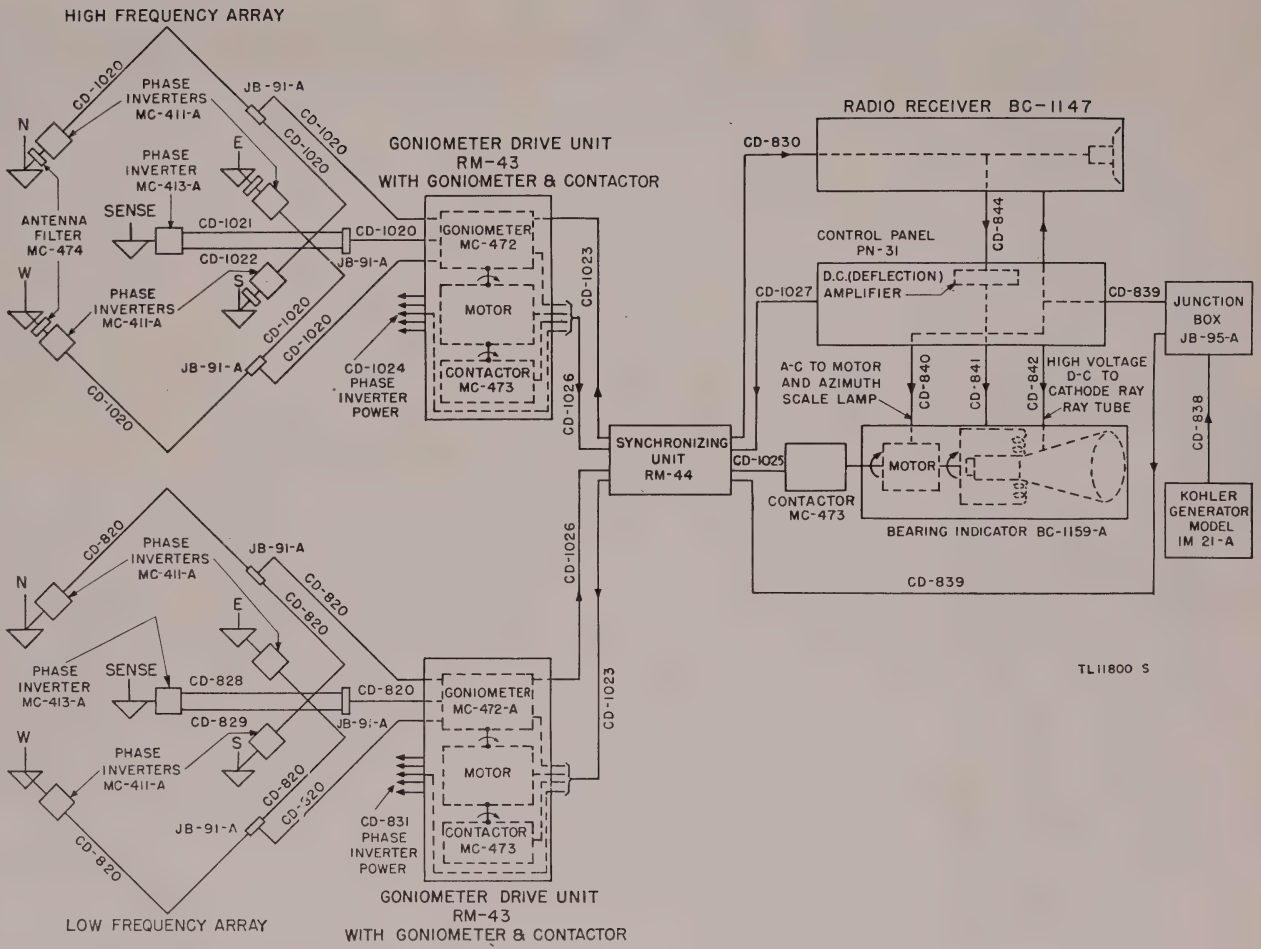


Figure 9. Radio Set SCR–502 (Direction Finding), block diagram.

SECTION II

DIFFERENCES BETWEEN MODELS

5. Physical Differences

This manual covers only one model of Bearing Indicator BC–1159–A.

6. Functional Differences

In Radio Set SCR–291–A (Direction Finding), the bearing indicator motor also drives the goniometer directly. In Radio Set SCR–502 (Direction Finding), the bearing indicator motor drives Contactor MC–473 which acts as a switch in Synchronizing Unit RM–44. Synchronizing Unit RM–44 serves to keep the motor of Goniometer Drive Unit RM–43 in pole alignment with the bearing indicator motor.

SECTION III

INITIAL REPAIR PROCEDURES*

7. General

Repair personnel should follow the procedure outlined in this manual when repairing and overhauling Bearing Indicator BC–1159–A. Because of the complexity of the equipment with which the indicator is associated reference should also be made to TM 11–256. The repair information in this and the following sections is presented in the order in which the repairman should actually perform the various operations on the equipment in the repair shop. This procedure permits repair of the equipment in the shortest time possible, resulting in performance comparable to that of new equipment.

8. Special Tools, Test and Cleaning Equipment

a. Tools and Miscellaneous Equipment.

Item	Description
Soldering iron, solder and flux	
Four rubber bands	
Pan	Approximately 12 x 12 x 13 in.
One sheet clear cellulose acetate.	9 x 9 x 0.0035 in. (Sig. C. stock No. 2–6125).
Spin type wrenches	Assorted sizes
Adjustable end wrenches	6 in. and 10 in., Williams or equivalent
15° end wrenches	Assorted sizes
Hexagon socket screw keys	1/8 (1/4 diam); 5/32 (5/16 diam); 5/16 (3/8 diam); and 7/32 (7/16 diam).
Glyptal	

b. Cleaning Equipment.

Item	Description
Three pints isopropyl alcohol	70 percent by volume
Bakelite block	2 x 3/4 x 1/8 in.
Crocus cloth	
Chee:e cloth	
Cloths	Lint-free
Cotton	Absorbent
Pipe cleaners	Tobacco smoker's
Solvent, Dry-cleaning	
Sandpaper	#00 and #000

c. Lubricants.

Item	Description
One-half pint oil	For grade of lubricant see TB SIG 69.
Oil can	1/2 oz. with 4 3/8 in. spout

d. Test Equipment.

Item	Description
Vacuum-tube voltmeter	Ranges: 0 to 100, 0 to 500, 0 to 1,000, 0 to 1,500 volts.
Ohmmeter	Ranges: 0 to 1,000, 0 to 10,000, 0 to 100,000 ohms, 0 to 1 megohm.

e. Accessories.

Item	Description
Antenna Equipment RC–223–A.	
Goniometer MC–412–A	
Radio Receiver BC–1147 or BC–1147–A.	
Control Panel PN–31 or PN–31–A.	
Radio Transmitter BC–1149 or BC–1149–A.	
Synchronizing Unit RM–44 and Contactor MC–473.	
Goniometer Drive Unit RM–43.	

9. Removal of Plug-in Parts

a. Removal of Cathode-Ray Tube (fig. 9). (1) Turn POWER and MOTOR switches OFF.

Caution: Never remove, adjust, open, or alter while power switch on Panel PN–31 or PN–31–A is turned on. Voltages dangerous to human life may accidentally be contacted by a repairman. Specific instructions will be given when the power supply may be turned on.

(2) Loosen the knurled screw on the swivel bolt (5) in figure 1 sufficiently to swing the swivel bolt clear of the projections on the optical housing.

(3) Swing back optical housing.

(4) Grasp tube and work it from side to side very slightly until it loosens, then pull out.

Caution: Handle gently. Do not force tube out of socket.

*Before any repairs or adjustments are made all authorized Modification Work Orders should be applied. Refer to FM 21–6 for list of applicable MWO's.

b. Removal of Control Box (figs. 1 and 4). (1) Support control box with one hand and loosen the knurled screw with the other.

(2) Grasp the control box and work it forward and backward very slightly while maintaining a downward pull until the connectors disengage.

c. Removal of Goniometer MC–412–A or Contactor MC–473 (fig. 1). (1) Remove antenna and receiver connections from the bottom of the goniometer, or the synchronizer connection from the contactor.

(2) Support the goniometer or contactor with one hand.

(3) Loosen the knurled screws on the swivel bolts on each side of the motor sufficiently to enable the swivel bolts to swing clear of the projections on the goniometer or contactor.

(4) Remove the goniometer or contactor carefully.

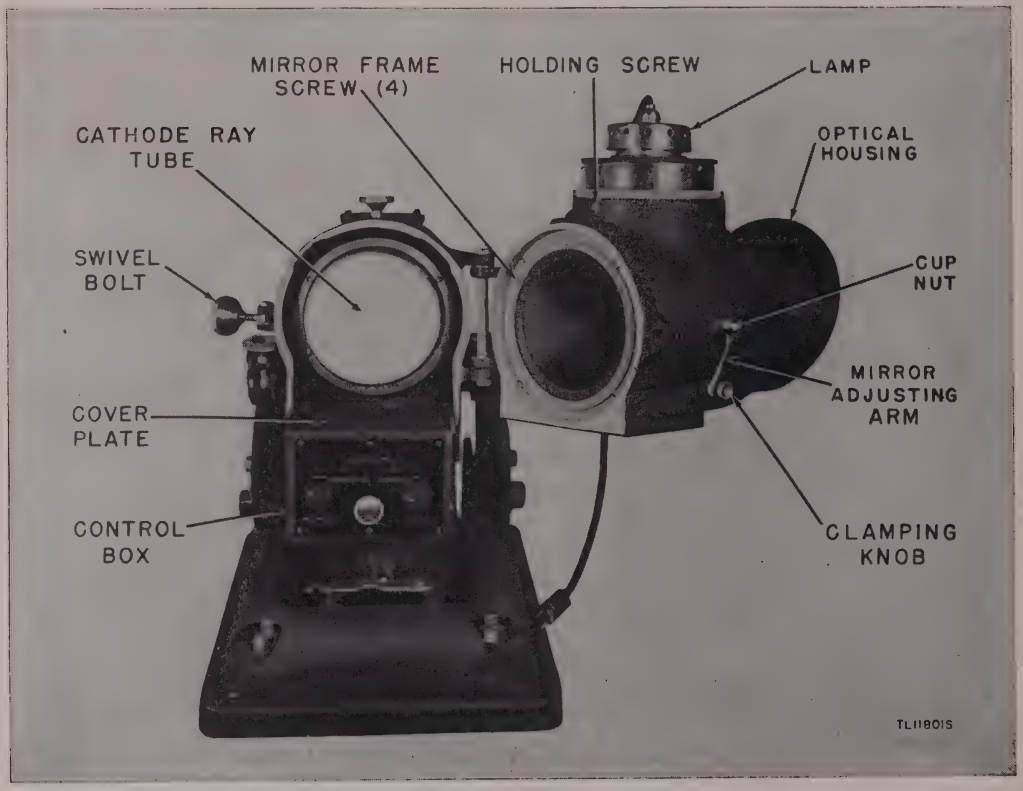


Figure 10. Bearing Indicator BC–1159–A, view of cathode-ray tube with optical housing swung back.

10. Routine Maintenance

a. General Cleaning. Thorough cleaning is necessary to insure the maximum performance of the unit. Remove the cathode-ray tube (par. 9*a*) and the control box (par. 9*b*) before cleaning the interior. Remove the cover plate from the control box. Remove dust which has settled within the bearing indicator and control box with dry compressed air. Do not use a blower to clean the optical parts because scratches may result. Use a soft, lint-free cloth to clean the parts within the optical housing. Remove any grease which adheres to a part by using a soft brush or cloth dampened with dry-cleaning solvent (SD).

b. Inspection. After the entire unit has undergone a thorough cleaning, inspect the parts and wiring for frayed, burned or general deterioration of insulation, burned or charred resistors, misalignment of moving parts, and dirty optical sys-

tem. Determine the condition of moistureproofing and fungiproofing. Inspect for loose or defective dials. Difficulty in rotating dials is indicated by a grating noise when dials are turned. Inspect the mechanical system; that is, brushes, slip rings, coupling, etc. Inspect motor by turning the rotor by hand and noting any abnormal grating or resistance. Inspect the goniometer end of the motor for eccentricity due to a bent shaft or looseness of the driving arm.

11. Maintenance of Slip Rings and Brushes

a. Cleaning Slip Rings and Brushes (fig. 5). (1) Turn POWER and MOTOR switches OFF.

(2) Remove screws from bakelite brush holders and allow the entire assemblies to hang over the side of the indicator.

(3) Saturate a pad of cheesecloth approximately 4 x 10 inches in dry-cleaning solvent (SD) and pass it under the rotating mount by slowly rotating the unit.

(4) Pull cheesecloth back and forth and sideways until all dirt and oil are removed from under the rotating mount.

(5) Remove pad and clean slip ring with the motor running by holding a small cheesecloth pad firmly against the rotating rings.

(6) Turn off the motor, clean the brushes and insides of brush holders with dry-cleaning solvent (SD), and carefully remount brush assemblies in operating positions.

(7) Replace excessively worn brushes, sticking or brittle brushes, or brushes which have corroded pigtails or broken strands.

b. Polishing Slip Rings (fig. 5). (1) The appearance of a light brown oxide film on the slip rings is beneficial and does not require polishing. However, make sure that any film present is the oxide film and not a combination of etching and tarnishing. The oxide film is somewhat shiny, whereas etching and tarnishing has a dull appearance.

(2) Turn MOTOR and POWER switch OFF.

(3) Lift brushes from slip rings and hold in position by allowing spring pressure arm to press against side of brushes.

(4) Wrap a piece of canvas cloth approximately 2 by 2 inches around a bakelite block 2 by ¾ by ⅛ inches or some other stiff, smooth surfaced material. In severe cases of cleaning, use crocus cloth and final polish with canvas cloth.

(5) With the indicator running press the block and crocus cloth firmly against the slip rings until the pitting or scoring has been removed and the slip rings have been restored to their original mirror finish.

(6) Before stopping the indicator, clean slip rings with a piece of cheesecloth.

(7) Replace brushes in their running position.

Caution: Polish and clean as instructed in *b* above. Never touch the slip rings with the bare fingers.

c. Tightening Slip Rings (fig. 5). (1) Turn MOTOR and POWER switches OFF.

(2) Loosen two setscrews in slip-ring retainer.

(3) Tighten slip-ring retainer by turning it counterclockwise (to the left) as viewed from the front of the indicator.

(4) Tighten slip-ring retainer setscrews.

(5) Turn the MOTOR switch ON and observe the brush springs pressure arm. Any noticeable up and down motion or vibration of the spring pressure arm indicates eccentricity of the rings, which must then be machined on a lathe and polished.

d. Machining Eccentric Slip Rings. (1) Swing back optical housing, drop control box, and remove tube and tube housing. (See fig. 4.)

(2) Remove screws from leather pad of flexible motor coupling holding axle and worm coupling. (See fig. 5.)

(3) Remove front and rear top bearing housing and lift out rotating assembly.

(4) Remove axle and worm coupling and mount rear shaft to rotating assembly in a lathe being careful not to damage gear on the shaft.

(5) Clamp the front of the assembly by means of the front oilite bearing in a lathe center rest and carefully machine all three slip rings just enough to remove eccentricity. Be careful when tightening steady support so as to prevent damage to bearing.

(6) Polish rings before removing from the lathe (see *b* above).

(7) Attach axle and worm coupling, carefully seating guide spacer in slot under locking screw.

(8) Reassemble in bearing indicator, being careful to fit pin next to oil hole in front bearing housing into the slot in the oilite bearing.

(9) Be very careful to properly shim the front bearing housing so as not to jam the oilite bearing.

(10) Check brush spring pressure. (See *e* below.)

(11) Realign goniometer. (See par. 38.)

e. Adjusting Brush Pressure on Slip Rings. (1) See that the spring pressure arm rides freely within the brush-holder slot without touching the sides.

(2) Check the spring tension with a suitable gauge graduated to ½ ounce, by observing the gauge reading when the pressure arm is just lifted from the brush. For best operation the tension should be from 2 to 4 ounces, preferably 2½ ounces.

(3) Correct the spring tension if necessary by adjusting the coils of the spring, not by bending the pressure arm.

12. Testing, Inspecting, and Cleaning of Motor

a. Testing. To test the motor, place the hand on the motor housing after the motor has been running 5 minutes. Note the temperature of the housing and whether there is excessive vibration. If the motor becomes too hot, or vibrates excessively, a thorough inspection should be made to locate the cause.

b. Inspecting and Cleaning. Proper functioning of the motor depends on careful inspecting of its outward appearance and its internal moving parts. Notice the external appearance of the motor. Carefully notice any oil leakage and whether mounting and joining bolts are loose. Inspect the mechanical coupling for excessive play and wear in the leather pad. The inspection points just mentioned, give important clues to motor trouble. Although the motor is totally inclosed, dust and dirt may enter the housing through openings in the parts joining one section of the housing to the other. An internal inspection should be made by disconnecting the coupling (par. 29*a*), removing the motor from its position, and removing the end housing. Remove all accumulations of oil, dirt, and dust with a soft brush or cloth moistened with dry-cleaning solvent (SD). Notice whether brush pressure on commutator is normal and whether there is commutator scoring.

13. Inspecting, Cleaning, and Testing of Cathode-ray Tube

a. Inspecting. Inspect the cathode-ray tube seating in its housing for loosened socket or housing. Remove the cathode-ray tube from the indicator. (See par. 9*a*.) Carefully check the tube prongs for corrosion, bending, and looseness. Inspect the base for a broken keyway and loosened envelope.

b. Cleaning. Wipe dust away with a dry cloth. If the dust and dirt cannot be removed with a dry cloth, use a cloth moistened with water. Wipe the tube dry with a clean dry cloth. Remove grease, oil, and grime with a cloth moistened with dry-cleaning solvent (SD). Remove any foreign matter from tube pins with a cloth or brush and then polish with crocus cloth. Clean the tube socket contacts with a tobacco smoker's pipe cleaner dipped in dry-cleaning solvent (SD). Then dry with pipe cleaner.

c. Testing. The cathode-ray tube should be checked for efficiency by replacing it with a good tube and comparing quality of operation. Note particularly intensity of beam and ease of controlling position of beam.

14. Lubrication

Trouble-free operation of the bearing indicator is dependent upon the proper lubrication of the front and rear bearings. Apply lubricating oil in the oil cups of the front and rear bearing housing. Do not oil excessively. See TB SIG 69 for the specific grade of oil to be used.

SECTION IV

PRELIMINARY TROUBLE-SHOOTING PROCEDURES

15. General

Upon completion of inspection maintenance, and initial repairs, the bearing indicator is ready for preliminary and operating tests. Before operating the bearing indicator, the repairman should become familiar with the test procedure, location of controls and connectors, operating instructions, and operating precautions. Perform operating tests with the bearing indicator connected to the proper associated equipment. The associated equipment is assumed to be in perfect operating condition.

16. Input Resistance Measurements

a. Cathode-ray Tube Circuit (fig. 25). Proceed as follows:

(1) Turn POWER and MOTOR switch OFF.

(2) Remove Cord CD–842 from connector J501 located on the bottom of the indicator.

(3) Measure the input resistance across the terminal pins of connector J501 in accordance with table I. The resistance readings obtained should be within 10 percent of the values specified in table I.

b. Deflection Coil Circuit (fig. 25). Proceed as follows:

(1) Turn POWER and MOTOR switch OFF.

(2) Remove Cord CD–841 from connector J502 located on the bottom of the bearing indicator.

(3) Measure the input resistance across the terminal pins of connector J502 in accordance with table I. The resistance readings obtained should be within 10 percent of the values specified in table I.

c. Motor, Heater, and Optical Assembly Lamp Circuit (fig. 25). Proceed as follows:

(1) Turn POWER and MOTOR switch OFF.

(2) Remove Cord CD–840 from connector J503.

(3) Measure the input resistance across the terminal pins of connector J503 in accordance with table I. The resistance readings obtained should be within 10 percent of the values specified in table I.

d. Resistance Readings. Where resistance readings are not within tolerance values, investigation should be made of the associated circuits, and resistance test made of each component part within the associated circuit.

Table I.—Input resistance values.

Connector	Measure from terminal pin	To terminal pin	Resistance
J501	B	C	1 megohm
	B	G	0.95 megohm
	B	D	Infinite
	B	F	Infinite
	B	S	Infinite
	S	G	Low ohms
	D	F	0.0 ohms
J502	C	B	900 ohms
	C	A	900 ohms
	A	B	800 ohms
J503	B	C	Low ohms
	A	D	30 ohms

17. Preparation for Operation

a. Plugging In Cathode-ray Tube. (1) Turn POWER and MOTOR switches OFF.

(2) Orient the tube so that the tube-base key is in approximately the same position as the keyway in the socket. Then insert the tube into the housing until it touches the socket.

(3) Rotate the tube gently in either direction until the key fits into the keyway.

Caution: Do not force tube into socket.

(4) Firmly push the tube in the socket working it from side to side very slightly until it is well seated.

(5) Close and lock the optical housing.

b. Attaching Goniometer MC–412–A or Contactor MC–473. (1) Align coupling pin on the goniometer or contactor with the goniometer driving arm on the rear of the motor.

(2) Slip the goniometer carefully into place at the rear of the indicator, making certain that the coupling pin engages the driving arm.

(3) Swing the swivel bolts into place and tighten the hand screws firmly.

c. Connection of External Units. (1) Connect Cord CD–840 from Control Panel PN–31–A to connector J503.

(2) Connect Cord CD–841 from Control Panel PN–31–A to connector J502.

(3) Connect Cord CD–842 from Control Panel PN–31–A to connector J501.

(4) Connect the proper cords to the goniometer or contactor. (See TM 11–256.)

18. Operating Instructions for Radio Set SCR–291–A (Direction Finding) and Radio Set SCR–502 (Direction Finding)

a. General. Operation of the equipment consists of tuning the receiver to the desired frequency and interpreting the patterns which appear on the bearing indicator screen. For more detailed operating instructions, see TM 11–256 covering Radio Set SCR–502 (Direction Finding) or TM 11–243 covering Radio Set SCR–291–A (Direction Finding).

b. Initial Alignment. The following operations must be performed in the order indicated before attempting to make bearing determinations.

(1) Interconnect the various units with the proper cords.

(2) Check the line voltage to make sure it is of the proper value (115 volts, 60 cycles, single-phase alternating current).

(3) Check circle alignment on the bearing indicator. (See par. 20.)

(4) Check for bearing indicator magnetization, if any, and demagnetize if necessary. (See par. 23.)

(5) Check goniometer alignment. (See par. 38.)

(6) Check for parallax in indicator optical system. (See par. 21.)

(7) Check phase inverter operation and balance.

c. Receiver Operation. (1) Turn receiver power switch ON and allow approximately 1 minute for tubes to warm up.

(2) Adjust receiver SENSITIVITY and A. F. GAIN controls to approximately ¾ maximum.

(3) Select proper frequency range and tune main tuning dial and ANT. COMP. to maximum output at the desired frequency.

(4) Turn control panel STANDBY-D. F.-SENSE switch to D. F.

(5) When the receiver is tuned to the desired frequency, observe the twin-leaf pattern on the bearing indicator screen and adjust receiver SENSITIVITY control until the pattern just closes at the center.

(6) While observing the pattern, retune main tuning and ANT. COMP. controls on receiver until pattern is of minimum width. This tuning corresponds to maximum receiver output for the given setting of SENSITIVITY control.

(7) Readjust receiver SENSITIVITY control until pattern again just closes at center.

(8) Turn ON beat-frequency oscillator (bfo) switch when monitoring continuous-wave (c-w) or interrupted-continuous-wave (i-c-w) signals.

(9) Two degrees of selectivity are provided. Preliminary tuning operations are usually simpler with selectivity switch in BROAD position. Bearing indications must be taken with switch on SHARP.

(10) The direction of travel of the received signal is indicated instantaneously by the position of the points of the twin-leaf pattern on the scale of the automatic bearing indicator. Sense, or the determination of which end of the pattern corresponds to the direction of arrival of the signal, is interpreted as follows. The sense pattern lies opposite the end of the twin-leaf pattern corresponding to the direct transmitter bearing. This relationship can be compared to an arrow in which the sense pattern is the tail of the arrow and the head (the leaf of the bearing pattern opposite the sense pattern) indicates the direction from which the signal is received.

(11) Set the audio gain control to any desired level.

19. Operating Test

a. Turn POWER and MOTOR switches ON.

b. Listen to the rotating parts of the indicator. Unusual noises such as rumbling, rasping, grating, and excessive vibration may indicate lack of proper lubrication, dust or dirt in bearings, brush bounce, worn couplings, or improper shaft alignment.

c. Use the sense of smell to indicate any possible overheating of the motor, capacitors, resistors, or deflection coils. Be careful to avoid confusing the smell of a burned-out part with that of a recently fungiproofed unit. Watch for any signs of smoke. Turn the equipment off immediately at the first sign of smoke.

d. Tune the receiver to an incoming signal and adjust the receiver SENSITIVITY control so that the twin-leaf pattern on the cathode-ray tube screen just comes together at the center.

e. Observe the shape of the bearing indicator pattern for indications of trouble. Such indications exist when pattern is nonsymmetrical, or when pattern refuses to close at the center and ridges on zero circle. (See pars. 23, 24, 25, and 26.)

SECTION V

ALIGNMENT PROCEDURE

20. Circle Alignment

a. Turn ON the POWER and MOTOR switches on Control Panel PN–31–A but leave the receiver POWER switch OFF.

b. Set the STANDBY-D. F.-SENSE switch to D. F.

c. Alternately adjust the FOCUS and INTENSITY controls on the bearing indicator control box until the circular trace on the indicator screen is sharp and clear but not too bright. (See fig. 11.)

d. Adjust the CIRCLE DIAMETER control to Control Panel PN–31–A until the circular trace is just inside the azimuth scale.

e. Center the circle by proper adjustment of the HORIZONTAL and VERTICAL POSITIONING controls on the bearing indicator control box. (See fig. 11.)

f. Alternately adjust the CIRCLE DIAMETER and POSITIONING controls until the circular trace exactly touches the inner circumference of the azimuth scale all around. Failure to obtain this condition because of an oval-shaped trace or one with slight bulges generally indicates magnetization of parts of the indicator near the rotating assembly. (See par. 23.) It is also possible but not probable that the mirror is not properly adjusted. If the mirror is not at 45° (fig. 23), the azimuth scale image will be oval and make the trace appear to be oval. Check parallax. (See par. 21.)

g. With the trace circular and perfectly centered, reduce the CIRCLE DIAMETER control until the circular trace is approximately 1/16 inch inside the azimuth scale image.

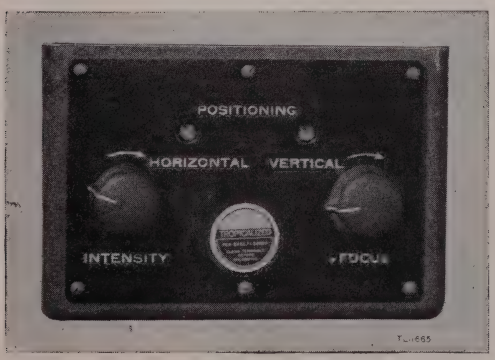


Figure 11. Bearing Indicator BC–1159–A, control box.

21. Parallax Correction

a. General. Parallax is noticed when the image on the cathode-ray tube screen is not in the same plane as the image of the azimuth scale. Readings of the bearing direction under this condition will be in error, depending upon the angle of the observer's eyes in relation to both images. If no parallax exists, the observer may look at both images from any angle and the same bearing indication will be read at all times.

b. Parallax Check. (1) Set the equipment in operation.

(2) Tune in a good steady signal with the STANDBY-D. F.-SENSE switch on D. F. Turn only the 0° antenna switch ON, and adjust the twin-leaf pattern for optimum width.

(3) Adjust the CIRCLE DIAMETER control if the points of the pattern are more than 1/16 inch from the inner circumference of the azimuth scale.

(4) Move your head from side to side and notice whether or not the points of the pattern at either 0° or 180° move with respect to the azimuth scale. In other words, does either end of the pattern read differently when you are looking at it from the right or from the left of the screen? If so, there is parallax because the azimuth scale image is not in the same plane as the tips of the pattern.

(5) In a similar manner, turn ON only the 90° antenna switch and check for parallax by viewing the pattern while moving your head up and down.

c. Elimination of Parallax. (1) Carefully adjust circle alignment. (See par. 20.)

(2) Set up the target transmitter 500 feet from the antenna array in line with the N-S antennas. Tune transmitter to a clear channel at 5 megacycles (mc) ± 0.5 mc with ICW-CW switch on CW.

(3) Turn ON only the 90° antenna switch and tune the receiver for a 90°–270° twin-leaf pattern. Turn lifting-ring adjustment until no parallax is observed.

(4) Turn antenna OFF switch to 90° and turn the ON switch to 0°. Adjust the mirror arm at the left of the optical housing until no parallax is observed for the 0°–180° pattern or until the azimuth scale is on the same side of the pattern at both ends (in front of or behind it).

(5) Repeat steps (3) and (4) above, readjusting circle alignment until parallax is eliminated.

(6) Check goniometer alignment. (See par. 38.)

SECTION VI

DETAILED TROUBLE-SHOOTING PROCEDURES

22. General

The location and replacement of a defective part in a minimum of time depends in a large measure upon the skill and experience of the individual repairman and upon the procedure used in locating the fault. The following paragraphs contain information for the location of faults in the bearing indicator, and include a table of resistance measurements (par. 27), information about voltage measurements (par. 28), and information about the removal and replacement of parts (par. 29). The faults described in the following paragraphs are based upon the premise that all the associated equipment is in perfect operating condition and the trouble originates only in the indicator.

23. Demagnetization of Indicator

a. Check for Magnetism (fig. 12). (1) Set the equipment in operation (par. 18) and tune in a strong signal, preferably continuous wave or one having a minimum of modulation, so as to insure a clear steady twin-leaf pattern.

(2) If the centers of twin-leaf trace are offset from one another as in *a*, figure 12, a part or parts of the rotating assembly has residual magnetism. The pattern may also be slightly bent as in *a*, figure 12.

(3) As a further check turn the receiver SENSITIVITY control to 10. The presence of a small circular trace, as shown in *b*, figure 12, instead of a dot also indicates residual magnetism in the rotating assembly.

(4) Turn the receiver POWER switch OFF. If the circular trace appears oval or has bulges or depressions, some of the studs or fixed portions of the indicator housing around the rotating assembly are magnetized sufficiently to deflect the cathode-ray tube spot from its normal circular path on the screen.

b. Demagnetizing Procedure (figs. 1 and 6). (1) Never attempt to demagnetize before carefully checking to make sure magnetism is present.

(2) If tests indicate magnetism, remove the demagnetizer from Chest CH–163–A and plug it into the AUX. 115V. A. C. outlet on Control Panel PN–31–A and proceed as follows.

(3) Turn the MOTOR, POWER, and HEATER switches OFF.

(4) Hold the demagnetizer about 3 feet from the indicator, and turn the demagnetizer on by depressing the snap switch on the cord. Bring the demagnetizer as close to the point to be demagnetized as possible, then withdraw it to the starting point, and turn it off. This operation should take about 15 or 20 seconds when the demagnetizer is moved at a uniform rate of speed.

Caution: Never leave the demagnetizer on more than 30 seconds for each operation or it will burn out.

(5) The demagnetizer has been designed to give a strong alternating-current field and still be physically small enough to fit inside the cathode-ray tube housing as required for demagnetizing the rotating assembly.

(6) Repeat this procedure for each of the fixed pins and studs whose locations are shown on figure 1 (1 to 11) and figure 5 (1 and 2). Points 1 to 7 refer to the corresponding pins and studs on both sides of the indicator. Points 6, 7, and 8 locate studs just inside the main housing. Point 5 is the clamp pin on the left side of the indicator and the optical housing hinge pin on the right hand side. Point 11 refers to the screws on the clamp which holds the lamp assembly in its shipping position (not visible in fig. 1). In demagnetizing points 5 and 6 (both sides of indicator) move the demagnetizer up and down over the extent of the pins while it is close to them.

(7) Now swing back the optical housing and carefully remove the cathode-ray tube. (See par. 9*a*.)

(8) Demagnetize the rotating assembly by inserting the demagnetizer, with a twisting motion, as far into the tube housing as it will go. During this operation snap the MOTOR switch ON and OFF in rapid succession so that the motor is either accelerating or coasting but not running at synchronous speed.

(9) Replace the tube (par. 17*a*), close the optical housing, check to make sure the magnetism has been removed (*a* above), and repeat these operations if necessary.

(10) Check circle alignment and parallax. (See pars. 20 and 21.)

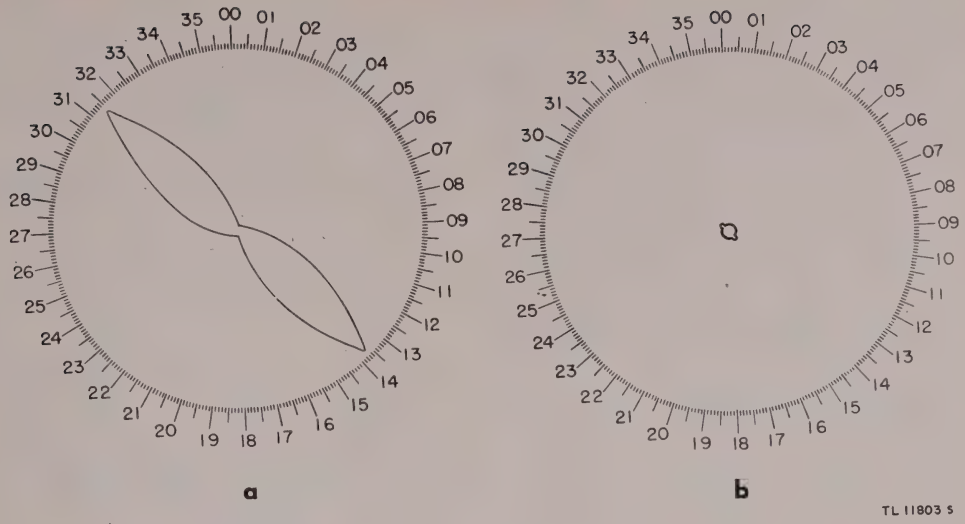


Figure 12. Bearing Indicator BC–1159–A, typical patterns showing indicator magnetization.

24. Saw-tooth Bearing Patterns

When bearing patterns having a distortion similar to teeth on a gear (fig. 13) are obtained with the receiver POWER switch OFF, the cause can be traced to one or more of the following causes: brush bounce (improper brush tension), dirt or irregularities on the matching surfaces of the slip rings and brushes, loose slip rings, and eccentric slip rings. For correction of any of the above conditions, see paragraph 11.

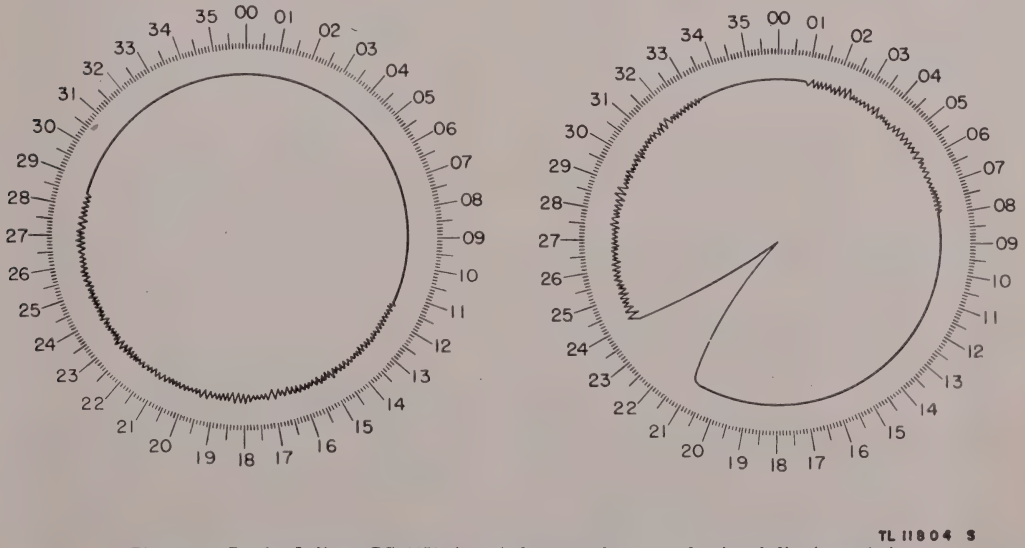


Figure 13. Bearing Indicator BC–1159–A, typical patterns due to poor brush and slip ring contact.

25. Reversed Sense Direction

A condition is sometimes encountered in which the sense pattern (fig. 14) indicates the direction for the incoming signal which is approximately opposite to the time direction. A condition of this type indicates that the deflection coil assembly is rotated 180° with respect to the goniometer. To correct this condition proceed as follows:

a. Turn POWER and MOTOR switches OFF.

b. Grasp the flexible leather coupling and loosen the locking screw on the axle and worm coupling with a screw driver. (See fig. 5.)

c. While holding the flexible coupling steady, rotate the graduated ring until it is 180° from its original position.

d. Tighten the locking screw.

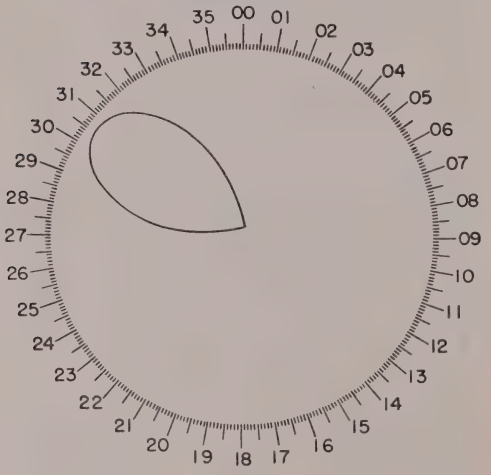


Figure 14. Bearing Indicator BC–1159–A, sense pattern.

26. Indicator Pattern Satisfactory with STANDBY-D.F.-SENSE Switch on D.F.

A condition in which a satisfactory pattern is obtained for the STANDBY-D. F. position but no pattern on the SENSE position, or vice versa, can be traced to an open in the deflection coil circuit. The open may be in the deflection coils, a broken pigtail, or one brush may not be making contact. To locate the open proceed as follows:

a. Turn POWER and MOTOR switches OFF.

b. Check continuity between slip rings C and A with a low reading ohmmeter, and between slip rings C and B. (See fig. 19.)

c. Check continuity between brushes C and A with a low reading ohmmeter, and between brushes C and B.

d. Clean and polish the slip rings and brushes. (See par. 11.)

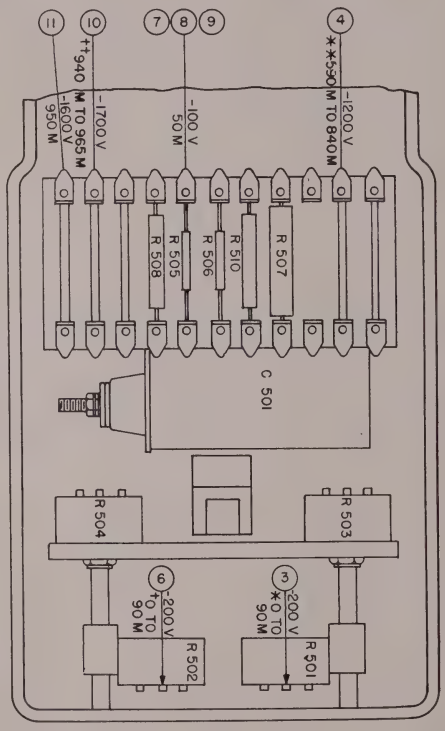
e. If the trouble is because of an open deflection coil, replace the defective coil. (See par. 29*b*.)

27. Control Box Resistance Measurements

Proceed as follows:

a. Turn POWER and MOTOR switches OFF.

b. Remove control box. (See par. 9*b*.)



NOTE * VARY R 502 † VARY R 501
** VARY R 503 †† VARY R 504

VOLTAGE MEASUREMENTS

CAUTION - VOLTAGES DANGEROUS TO LIFE.
POWER CABLE TO CONTROL PANEL PN-31-A.
A-C INPUT TO CONTROL PANEL 117 V, 60 CYCLES.
COVER PLATE ON INDICATOR CONTROL BOX REMOVED.
MEASUREMENTS TO CHASSIS WITH AN ELECTRONIC VOLTMETER.
THESE POINTS CONNECT TO THE CATHODE-RAY TUBE PINS CORRESPONDING TO NUMBERS IN CIRCLES.
TUBE IN SOCKET, ALL CONTROLS MAXIMUM CLOCKWISE.

RESISTANCE MEASUREMENTS

DISCONNECT POWER INPUT OF UNIT FROM SOURCE, AND ALL OTHER CORDS.
TUBE REMOVED.
MEASUREMENTS TO CHASSIS WITH A VOLTOHMMETER.

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Figure 15. Bearing Indicator BC–1159–A, control box lay-out diagram showing voltage and resistance values.

c. Remove screws fastening the cover plate of the control box and remove the cover plates.

d. Measure the resistance of the resistors in the control box and point-to-point resistances with a high-range ohmmeter in accordance with table II and figure 15.

e. Readings should be within 10 percent of the values given in table II and figure 15.

Table II.—Resistance measurements.

From one side of—	To other side of—	Conditions	Resistance (ohms)
R505	R505		50,000
R506	R506		50,000
R507	R507		300,000
R508	R508		100,000
R510	R510		200,000
C501(inside)	Chassis		1,000,000
From one side of—	**To arm of—**	**Conditions**	**Resistance (ohms)**
R501	R501	Vary VERTICAL POSITIONING control.	0–100,000
R502	R502	Vary HORIZONTAL POSITIONING control.	0–100,000
R503	R503	Vary FOCUS control.	0–250,000
R504	R504	Vary INTENSITY control.	0–25,000

28. Voltage Measurements

Proceed as follows:

a. Turn POWER and MOTOR switches OFF.

b. Loosen the knurled screw on the swivel bolt (5), (fig. 1) sufficiently to swing the swivel bolt clear of the projections on the optical housing.

c. Swing back the optical housing.

d. Remove the screws fastening the cover plate of the control box and remove the cover plate.

e. Turn POWER and MOTOR switches ON.

f. Turn all controls on the control box full clockwise for maximum voltage.

g. Measure the voltages between the various resistances and chassis with a vacuum-tube voltmeter in accordance with figure 15. Values of voltage that differ from the normal values more than ± 20 percent should be considered a source of trouble and investigated.

Warning: Voltages at all points exposed are dangerous to life.

Note: The pins on the cathode-ray tube socket are not directly accessible.

29. Removal and Replacement of Defective Parts

a. Replacing Flexible Motor Coupling (fig. 4). (1) To replace the leather pad, remove the four screws in the pad, loosen the setscrew on the motor half of the coupling, insert the new pad, replace the screws, and lock the setscrew on motor shaft.

(2) If the entire flexible coupling assembly must be replaced, remove the rotating assembly and reassemble as outlined in paragraph 11*d*(1) to (4) and (7) to (9).

(3) Realign goniometer. (See par. 38.)

b. Replacing Deflection Coils. (1) Turn OFF all power switches.

(2) Swing back the optical housing, drop control box, and remove tube and tube housing. (See fig. 4.)

(3) Open the top cover of the indicator and check continuity of deflection coils by placing the analyzer prods across the coil terminals which can be reached from the top of the bearing indicator. Connect prods to the meter resistance jacks. A reading of infinity indicates an open coil.

(4) Unsolder the leads to the defective coil and tag them so there will be no mistake in connecting them to the proper terminals of the replacement coil.

(5) Straighten the bent lamination holding the coil by pressing on it with a screw driver from the front of the bearing indicator. Remove the coil.

(6) Insert the new coil and secure it by bending over the front lamination as before. Resolder the leads to the terminals.

(7) Replace the tube housing and cathode-ray tube, attach the control box, and close the optical housing.

(8) Check for goniometer alignment (par. 38) and parallax (par. 21), correcting if necessary. If parallax is found, first check to see if the cathode-ray tube is properly seated.

c. Replacing Azimuth Scale and Cleaning Optical Assembly. (1) Remove lamp assembly. (See fig. 1.)

(2) Loosen setscrew on lifting ring and remove lamp housing. (See fig. 1.)

(3) Take out retaining ring screws and retaining ring (fig. 16) being careful not to drop azimuth scale and diffusing glass which will now fall out (hold lamp housing with scale side up).

(4) Observe that when looking at the azimuth scale before removing it from the housing that the scale numbers read backward.

(5) Lift out azimuth scale, spacer, diffusing glass, and reflector in this order. (See fig. 16.)

(6) Carefully remove any collection of dust with a clean, soft, dry piece of chessecloth or a camel's-hair brush.

(7) Replace parts in order using a new azimuth scale if the old one is defective.

(8) Be sure the azimuth scale numbers read backward after assembly and that the scale is exactly centered before replacing the retaining ring and screws.

(9) Replace assembly including the lamp in lifting ring, but do not tighten setscrew.

(10) Turn the scale alignment ring (fig. 1) until the 0° division on the azimuth scale is at the top of the cathode-ray tube screen.

(11) Eliminate parallax. (See par. 21.)

(12) With the target transmitter set up as instructed in TM 11–243, turn ON only the 0° switch on the control panel and carefully adjust the receiver to give a good twin-leaf pattern.

(13) Readjust the scale alignment ring until the 0° division on the azimuth scale is exactly at the upper tip of the pattern.

(14) If the other end of the pattern differs from 180° by more than 0.5°, demagnetize the indicator (par. 23) and repeat instructions given in steps (13) and (14) as often as necessary.

(15) Now tighten the setscrew in the lifting ring. (See fig. 1.)

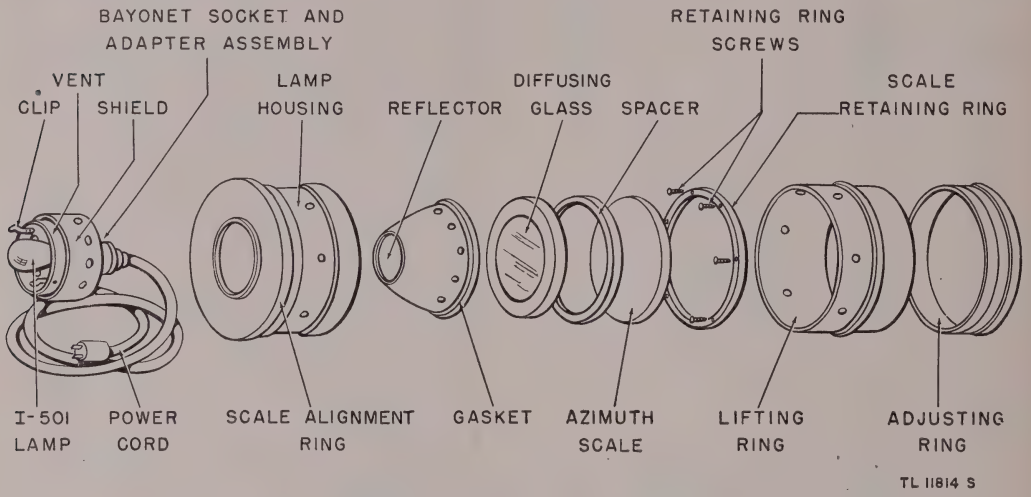


Figure 16. Bearing Indicator BC–1159–A, components of lamp assembly.

d. Replacing Assembled Mirror. (1) Swing optical housing to one side.

(2) Remove cup nut on mirror adjusting arm with a ⅝-inch wrench.

(3) Remove the four mirror frame screws. (See fig. 4.)

(4) Remove 1¼-inch screw in coupling pin under cup nut.

(5) Steady the mirror support ring with one hand, loosen clamping knob half way and drop adjusting arm, allowing it to hang from clamping knob.

(6) Carefully withdraw mirror support ring so as not to tilt mirror.

(7) Place the assembly on a table, mirror up, with slotted bracket pin to your left, and turn the mirror so that the pivot bracket mounting screws are on top.

(8) Observe that the mirror mounting screws are nearer the top than the bottom of the mirror.

(9) Replace mirror with new one.

(10) After tightening screws, place a hardwood block covered with cheesecloth under the mirror frame. Use hammer and screw driver and stake screws.

(11) Replace mirror mount in optical housing with slotted coupling pin to right, being careful to keep mirror at 45° position so as not to hit azimuth scale on curved antiglare mirror toward front of optical housing.

(12) Replace adjusting arm in slot but do not replace its 1¼-inch holding screw yet.

(13) Replace two mirror frame screws, and then replace the 1¼-inch holding screw in the adjusting arm.

(14) Loosen clamping knob (fig. 4) and test action of mirror adjusting arm.

(15) Replace the remaining two mirror frame screws and the cup nut over adjusting arm, being sure all are tight.

(16) Check for and eliminate parallax. (See par. 21.)

e. Replacing Cellulose Acetate on Mirror Frame. (1) Place the mirror frame in the pan with the tapped screw holes down and fill pan with alcohol.

(2) Immerse cellulose acetate film in the alcohol.

(3) When the cellulose acetate sheet becomes pliable, fasten it to frame with rubber bands so that bands draw into groove provided.

(4) While still immersed in alcohol, stretch the cellulose acetate sheet until all wrinkles are removed.

(5) Remove the frame from the alcohol bath, being careful not to touch the mirror film with fingers. Carefully wipe off the excess alcohol with absorbent cotton.

(6) When the mirror is dry, fasten the mirror clamping band securely in place and trim off the excess cellulose acetate sheet with a sharp knife or razor blade.

f. Replacing Variable Resistors Controls.

(1) Remove control box. (See par. 9*b*.)

(2) Remove cover plate.

(3) Loosen setscrew on knob with an Allen hexagon wrench and remove knob.

(4) Unsolder connections, one at a time, and tag to insure proper connection to replacement unit.

(5) Remove hexagon nuts and washers from shaft bushings, mount replacement unit, and resolder all connections.

30. Refinishing and Painting

If the aluminum housing is badly scarred or damaged, the surface should be thoroughly cleaned and then repainted to prevent corrosion. Remove all rough spots using #0000 or #000 sandpaper. Rub the bare spots with #0000 sandpaper until a smooth bright finish is obtained. Dry-cleaning solvent (SD) will help remove rust. In severe cases alternate the use of dry-cleaning solvent (SD) and sandpaper until the surface is clean. After rust has been removed, clean surface with dry-cleaning solvent (SD) before applying paint. When the case has a large number of scars, it should be removed and spray-painted. If there are only a small number of scars, paint may be applied with a small brush. The paint used should be in accordance with existing regulations.

Caution: Do not use steel wool. Small particles of the steel may enter the case and cause short circuits and scoring of the slip rings.

31. Moistureproofing and Fungiproofing

After completing the repairs, apply moistureproofing and fungiproofing varnish with a brush to the repaired connections and to all other parts from which the coating was removed. Avoid applying the varnish to any points where electrical contacts must be made or broken (switches, plugs, relay contacts, terminals, and socket pins). These points should be masked with masking tape before applying the varnish. Before reassembling the repaired equipment, note the date when moistureproofing and fungiproofing treatment was last applied. If more than 6 months have elapsed since that date, it will be necessary to repeat the entire process. After the bearing indicator has been reprocessed, mark the unit MFP followed by the date of completion of treatment. See TB SIG 13 for a detailed description of the varnish-spray method of moistureproofing and fungiproofing with a list of the supplies and equipment required. Step-by-step instructions for moistureproofing and fungiproofing the bearing indicator are contained in TM 11–256 covering Radio Set SCR–502 (Direction Finding).

Warning: Varnish spray may have toxic effects if inhaled. To avoid inhaling spray, use a respirator if available; otherwise, fasten cheesecloth material over nose and mouth in accordance with existing shop practices.

SECTION VII

FINAL TESTING

32. Performance Requirements

a. General. Performance tests of Bearing Indicator BC–1159–A must be made with the bearing indicator connected to its associated equipment (Radio Set SCR–502 (Direction Finding) or Radio Set SCR–291–A (Direction Finding)). After all repairs are made and alignments completed, inspect and test the bearing indicator for compliance with the requirements listed in the following subparagraphs.

b. Mechanical Requirements (fig. 5). (1) Rotating assembly should turn easily, silently, and with no vibration.

(2) Goniometer driving arm at the rear of the motor should be securely fastened to the shaft.

(3) Flexible coupling should be fastened securely to both shafts, and the leather washer should not be worn or split.

(4) Slip rings should be tight, true, clean, and polished. (See par. 11.)

(5) Brushes should have sufficient length, move freely in their holders, make proper contact with the slip rings, and have the proper pressure on the slip rings. (See par. 11.)

(6) Bearings should be lubricated. (See par. 14.)

(7) Cathode-ray tube should be firmly seated in its socket.

(8) Control box should be firmly mounted on the indicator housing.

(9) Threads on swivel bolts should not be stripped, nor should swivel bolts swing freely when loosened.

(10) Optical housing should joint properly to the body of the bearing indicator.

(11) Cord of the lamp assembly should not be frayed or broken.

(12) Connector sockets should not be deformed or broken. Socket threads should not be stripped.

(13) Tilt regulator threaded shaft should not be bent.

c. Electrical and Magnetic Requirements. (1) FOCUS and INTENSITY controls should not shift the circle more than $\frac{1}{8}$ inch.

(2) The circle diameters should coincide with the outside ends of the azimuth scale graduations when 10 to 12 milliamperes (ma) d-c is passed through the deflection coils. (See par. 20.)

(3) Points 1 to 11 (fig. 1) should be completely demagnetized (par. 23).

(4) Motor must rotate at the proper synchronous speed (1,800 revolutions per minute (rpm)).

(5) Heater should operate at ambient temperatures less than 70° F.

d. Optical Requirements. (1) Lamp should light at normal brilliance.

(2) Scale should be properly aligned (0° at the top).

(3) Parallax should be eliminated at all points of the scale. (Test for parallax at 0°–180° and at 90°–270° in accordance with par. 21.)

e. Operational Test (figs. 14 and 17). After completion of alignments, inspections, and tests, the set should be tuned to a known signal from a known direction. (Radio Transmitter BC–1149–A (Target) may be used.) Obtain the bearing direction of this known signal by observing the twin-leaf pattern and the sense pattern. If the direction indicated by the bearing indicator is within 1° of the known direction of the signal, the bearing indicator is in good operating condition.

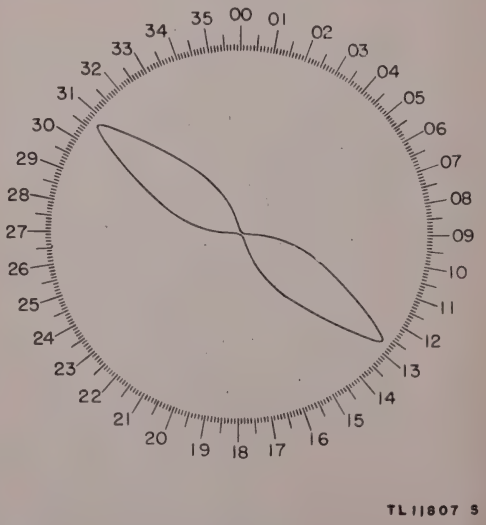


Figure 17. Bearing Indicator BC–1159–A, bearing pattern.

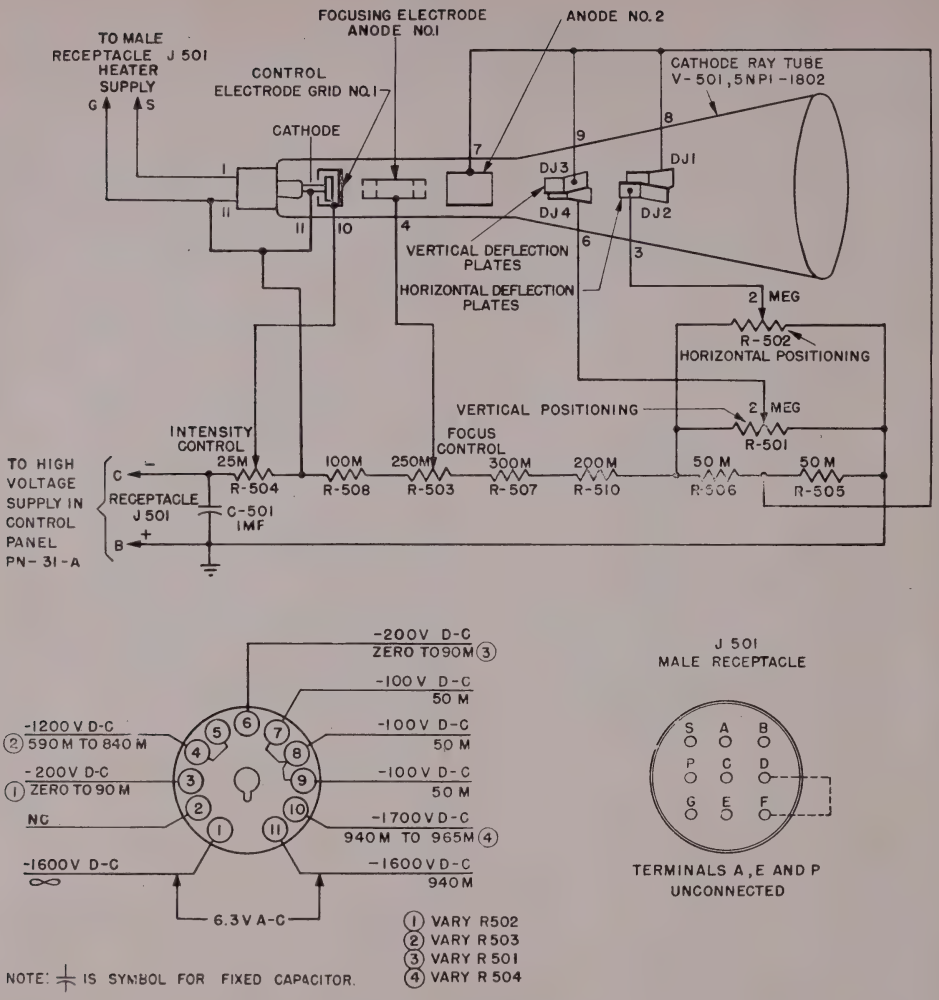
SECTION VIII
INDIVIDUAL STAGE AND CIRCUIT REPAIR DATA

33. Cathode-ray Tube Circuit

a. General (fig. 18). Voltages are introduced into the cathode-ray tube circuit from Control Panel PN–31–A by Cord CD–842 through receptacle J501. Capacitor C501 filters the high-voltage direct current. The horizontal and vertical deflection plates, DJ1 and DJ2, and DJ3 and DJ4, respectively, are used only for centering the patterns on the screen. Variable resistor R504 controls the intensity of the electron beam, and variable resistor R503 controls the focusing of the beam. Variable resistors R501 and R502 control the vertical positioning and horizontal positioning, respectively.

b. Parts Data for Cathode-ray Tube Circuit.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
C501	3DB1.20010–2	CAPACITOR: 1-mf, —0% +20%; 2,000 vdcw; Dykanol type 20010.	Filter.
J501	2Z7119.2	CONNECTOR, male: Amphenol 3102–28–4P	Cathode-ray tube supply.
R501	2Z7274–2	RESISTOR, variable: 2-meg, ±20%; ½-watt; IRC type CS; taper C.	Vertical positioning control.
R502	2Z7274–2	RESISTOR, variable: same as R501	Horizontal positioning control.
R503	2Z7272–18	RESISTOR, variable: 250,000-ohm, ±20%; ¼-watt; IRC type CS; taper A.	Focus control.
R504	2Z7270–9	RESISTOR, variable: same as R503	Intensity control.
R505	3Z6650–52	RESISTOR: 50,000-ohm, ±10%; ½-watt; Erie type 504	Dropping for second anode.
R506	3Z6650–52	RESISTOR: same as R505	Dropping for second anode.
R507	3Z6730–2	RESISTOR: 300,000-ohm, ±10%; 2-watt; IRC type BT–2, or equal.	Dropping for first anode.
R508	3Z6700–59	RESISTOR: 100,000-ohm, ±10%; 1-watt; IRC type BT–1, or equal.	Dropping for first anode.
R510	3Z6720–8	RESISTOR: 200,000-ohm, ±10%; 1-watt; IRC type BT–1, or equal.	First anode.
V501	2J5NP1	TUBE, electron: cathode-ray; type 5NP1–1802	Indicator.



VOLTAGE MEASUREMENTS

CAUTION - VOLTAGES DANGEROUS TO LIFE.
POWER CABLE TO CONTROL PANEL PN-31-A.
A-C INPUT TO CONTROL PANEL 117V, 60 CYCLES.
COVER PLATE ON INDICATOR CONTROL BOX REMOVED.
MEASUREMENTS TO CHASSIS WITH AN ELECTRONIC VOLTMETER.
ALL CONTROLS FULL CLOCKWISE.

RESISTANCE MEASUREMENTS

DISCONNECT POWER INPUT OF UNIT FROM SOURCE, AND ALL OTHER CORDS.
TUBE REMOVED.
MEASUREMENTS TO CHASSIS WITH A VOLT-OHMMETER.

TL11809-S

Figure 18. Bearing Indicator BC-1159-A, cathode-ray tube circuit, schematic diagram.

34. Deflection Coil Circuit

a. General (fig. 19). The deflection coil circuit consists of four coils mounted on a rotating laminated iron yoke, and three slip rings to which the coils are connected. Opposite pairs of coils are connected in series to produce additive fields. Carbon brushes are used for electrical connections between the rotating and stationary circuits. Cord CD–841 connects the deflection coil circuit from Control Panel PN–31–A to plug J502. Figure 20 shows the relationship of the indicator deflection coil circuit to the deflection amplifier and receiver indicator channel circuits.

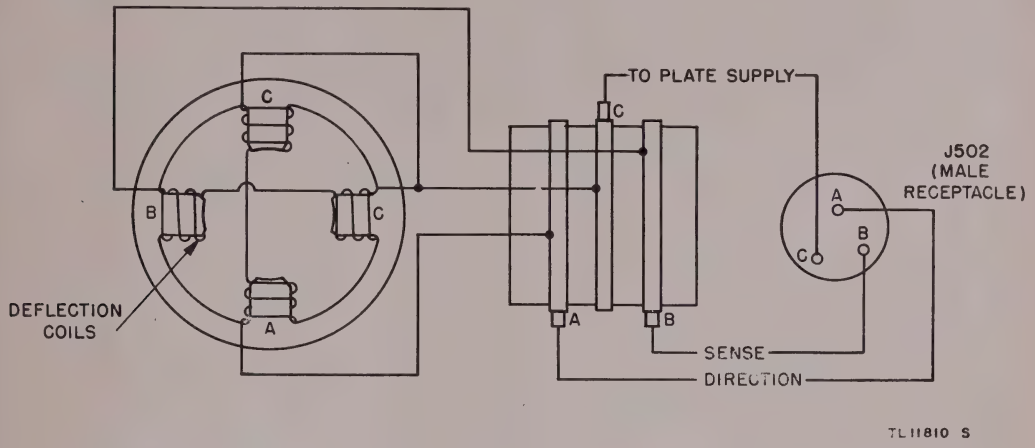


Figure 19. Bearing Indicator BC–1159–A, deflection coil circuit detail, schematic diagram.

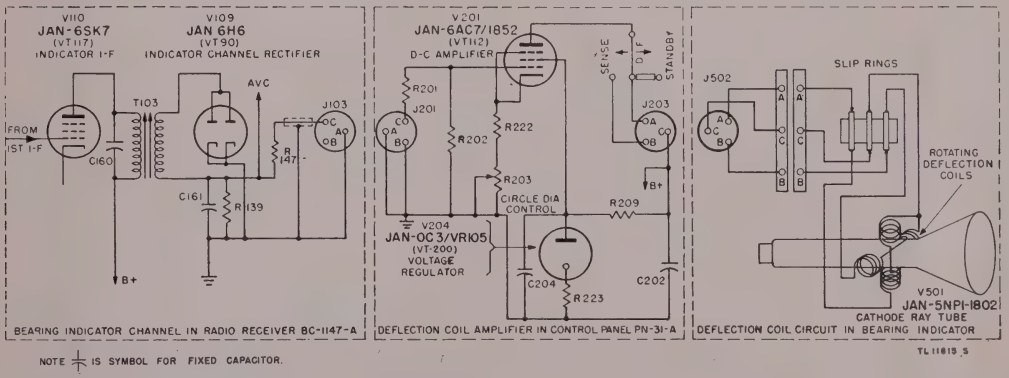


Figure 20. Bearing Indicator BC–1159–A, composite schematic diagram of receiver indicator channel, deflection amplifier, control panel, and bearing indicator deflection circuit.

b. Parts Data for Deflection Coil Circuit.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
	2C1557–1159A/B1	BRUSH: 0–15 speer grade; carbon	Contact.
	2C1557–1159A/B1/1	SPRING	Spring for brushes.
	2C1557–1159A/B1/2	SPRING	Spring for brushes.
	3C388	COIL, deflection	Control of indicator.
J502	2Z8799–187	RECEPTACLE, male: AN–3102–22–9P	Deflection coil supply.

35. Motor Circuit

a. General (fig. 21). Motor B501 is a ¼-hp, single-phase, 60-cycle, capacity-start synchronous motor. A centrifugal switch within the motor cuts out capacitor C503 when the motor has reached the 1,800 rpm operating speed. A-c power for the motor is obtained from Control Panel PN–31–A through Cord CD–840 connecting to plug J503.

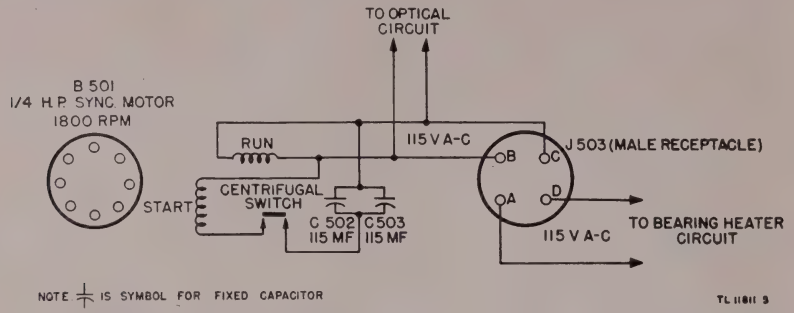


Figure 21. Bearing Indicator BC–1159–A, motor circuit, schematic diagram.

b. Parts Data for Motor Circuit.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
B501	3N3000A25–1	MOTOR: ¼-hp; 115-v a-c; synchronous; 1,800 rpm.	Driving unit.
C502	3DB115–1	CAPACITOR: 115-mf; 110-v a-c; electrolytic; type EPMO–3.	Motor starting.
C503	3DB115–1	CAPACITOR: same as C502	Motor starting.
J503	2Z8799–209	CONNECTOR, male: Amphenol 3102–22–10P.	A-c motor and heater supply.

36. Bearing Heater Circuit

a. General (fig. 22). Heater R509, which is controlled by thermostat S501, keeps the front bearing lubricant from becoming too stiff at low temperatures. Heater R509 is located in the space beneath the bearings. Thermostat S501 closes at 70° F. and opens at 80° F. The heater and thermostat can be reached after the under cover plate (fig. 1) is removed.

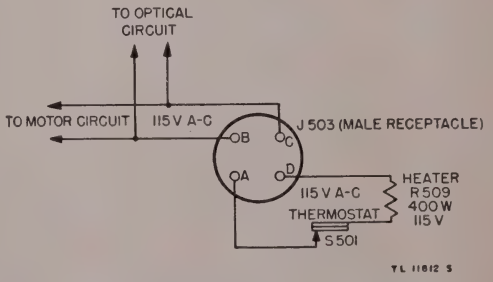


Figure 22. Bearing Indicator BC–1159–A, bearing heater circuit, schematic diagram.

b. Parts Data for Bearing Heater Unit.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
R509	2Z5015–13	RESISTOR: 115-v; 400-w; chromolex disk heater.	Heater.
S501	3Z9652–4.1	THERMOSTAT, on-off: SPST; 1-contact; 10-amp; Klexon thermo-snap switch.	Control temperature.

37. Optical System

a. General (figs. 23 and 24). The function of the optical system is to reflect the image of the azimuth scale so that it appears to encircle the cathode-ray tube in the plane of the screen. Light from lamp I–501 is concentrated on a ground glass diffusing screen by the reflector. The azimuth scale or graduated ring, consisting of an opaque glass disk with transparent scale markings, is mounted directly beneath the diffusing glass. A transparent cellulose acetate mirror is mounted below the scale at

equal distances from the scale and cathode-ray tube screen. Light passing through the azimuth scale markings is reflected out to the observer's eye and appears to come from the azimuth scale image at the cathode-ray tube screen, while light from the screen pattern goes directly to the eye through the mirror. Parallax between the azimuth scale image and the screen patterns is eliminated by adjusting the lifting ring in the lamp assembly. (See fig. 1.) This adjusts the scale to mirror distance so that the scale image coincides exactly with the screen pattern. The scale is oriented by the alignment ring (fig. 1) until the 0° North marking is at the top of the screen. The curved mirror eliminates glare by reflecting unwanted light rays out of the line of vision.

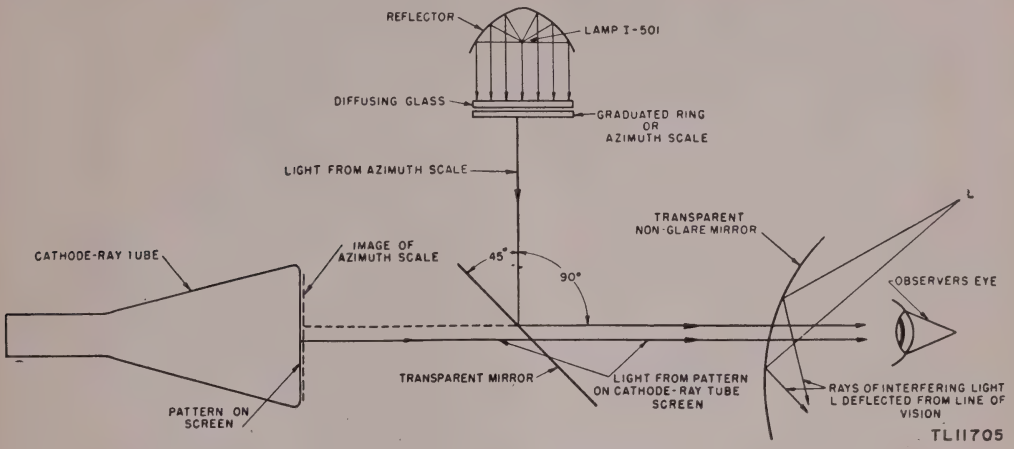


Figure 23. Bearing Indicator BC–1159–A, optical system, functional diagram.

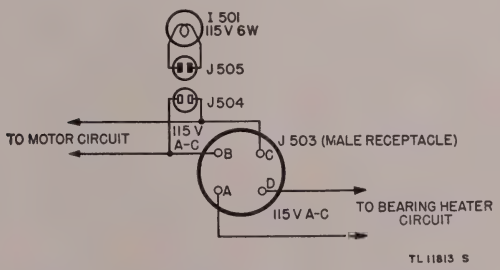


Figure 24. Bearing Indicator BC–1159–A, electrical circuit of optical system, schematic diagram.

b. Parts Data for Optical System.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
I501	6Z6815–22	LAMP: 6-w; 115–120-v; double contact bayonet base	Azimuth scale lighting.
J503	2Z8799–209	CONNECTOR, male: Amphenol 3102–22–10P	A-c motor and heater supply.
J504	6Z7783	CONNECTOR, female: recessed; No. 757 type MC	Scale light supply.
J505	6Z7591–9	CONNECTOR, (type): No. 757 type MC	Scale light supply.
	2Z3724.4	SCALE, azimuth: glass; graduated	Scale for pattern reading.
	2Z6125–1	LENS: ground glass	Diffusing lens.
	2Z6125	LENS: clear colorless celluloid	Antireflection lens.
	3Z12059–23	LUG: terminal; No. 2102–4	
	3Z12059–13	LUG: terminal; No. 2102–6	
	3Z12072–16	LUG: terminal; type 101	
	2Z4880–9	MIRROR: 9 x 9 x .0035-in.; clear cellulose acetate	Reflects scale.
	2Z6550	MIRROR ASSEMBLY: mirror mounted in holder	Reflects scale.
	2Z5885–6	Socket and adaptor assembly	For scale light.

SECTION IX

SUPPLEMENTARY DATA

38. Alignment of Goniometer MC–412

a. Routine Operation Check. (1) Set the equipment in operation using FILAMENT switch position 1.

(2) Tune in a strong signal at 5 ± 0.5 mc, if possible, which gives a steady twin-leaf pattern. If no satisfactory signal is found, the target transmitter must be used.

(3) Turn OFF the 90°, 180°, and 270° switches leaving only the 0° switch ON and readjust the receiver SENSITIVITY control until the pattern just closes at the center.

(4) The points of the pattern should read 0° and 180° on the azimuth scale.

(5) Check the 90°–270° pattern by turning the 0° switch OFF and the 90° switch ON.

(6) If the 0° and 90° readings are in error by more than 1°, proceed as instructed in *b* below. For errors of less than 1° loosen the setscrew and turn the scale alignment ring. (See fig. 1.)

b. Alignment and Check with Target Transmitter. (1) Set up Radio Transmitter BC–1149–A (Target) exactly in line with the north and south antennas at a distance of approximately 500 feet from the antenna system.

(2) Turn the target transmitter ON-OFF switch ON, the HI-LO switch to HI, the ICW-CW switch to ICW.

(3) Tune the transmitter to approximately 5 mc and then tune it in on the receiver.

(4) If an interfering transmitter is observed at this frequency, detune the receiver slightly to a clear channel, retune the target transmitter to this frequency, and switch the ICW-CW switch to CW.

(5) Carefully adjust the receiver.

(6) Adjust scale alignment ring (fig. 1) until 0° and 180° figures on azimuth scale are vertical.

(7) Leave the 0° switch ON and turn the 90°, 180°, 270° switches OFF. If the twin-leaf pattern does not point exactly to 0° proceed as follows:

(8) Record the exact reading of the pattern in degrees plus or minus from 0° on the azimuth scale.

(9) Now turn OFF the MOTOR and POWER switches on the control panel and open the cover on top of the bearing indicator.

(10) Grasp the flexible leather coupling (fig. 5) and loosen the locking screw on the axle and worm coupling with a screw driver.

(11) While holding the flexible coupling steady, observe the graduated ring reading under the index stud, and turn the screw driver coupling adjustment until the graduated ring has moved the same number of degrees as the error in the 0° pattern((8) above) but in the opposite direction. Then tighten the locking screw. For example, if the 0° pattern ((7) and (8) above) read 358° on the azimuth scale (minus 2° alignment error) and the graduated ring reading under the index stud is 180°, turn the coupling adjustment (fig. 5) so that the 182° division on the graduated ring lines up with the index stud. On the contrary, if the pattern reads 2° (plus 2° alignment error) the coupling adjustment should be turned to change the graduated ring reading from 180° to 178°.

(12) Start the indicator motor, recheck the 0° pattern orientation according to (7) above. If the required adjustment is less than 1°, loosen the setscrew and turn the scale alignment ring (fig. 1); if more than 1°, repeat step (11) above.

(13) Turn the 90° switch ON, the 0° switch OFF, and check the 90° pattern, but make no further adjustments.

39. Miscellaneous Parts Data

a. General. There are parts of Bearing Indicator BC–1159–A which are not a part of any particular circuit. For this reason they are listed separately under the heading miscellaneous parts data.

b. Miscellaneous Parts Data.

Ref symbol	Signal Corps stock No.	Name of part and description	Function
	2Z7227–4	CONNECTOR, male: type 274P	
	2Z5574.1	CONNECTOR, female contact: banana type	
	2Z6912	PAD, coupling: flexible leather motor coupling	Coupling.
	2Z8495.6	SLEEVE, rubber mounting: black neoprene	Shock absorber.
		CONDUCTOR: hard metal drawn tubing	Slip ring.
		BEARING, ball: steel; No. 3202	Bearing.
		BEARING: oilite oil cushion bronze	Bearing.
		Axle and worm	Alignment.
		JAMNUT AND WORM GEAR CARRIER: special	Alignment.
		BEARING, ball: steel; double-shielded with aircraft grease No. 201–DD.	Front bearing goniometer.
		BEARING, ball: steel; double-shielded No. 36–DD	Rear bearing goniometer.
		BEARING, ball: steel; double-shielded No. 6202–RS	Front-rear bearing for BC–1159–A drive motor.

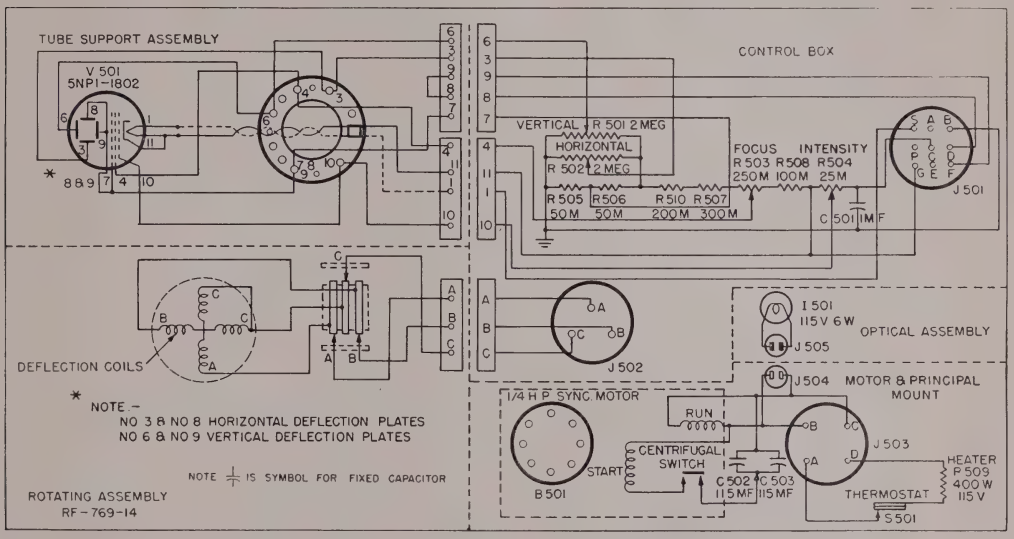


Figure 25. Bearing Indicator BC–1159–A, over-all schematic diagram.

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